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Fringe Firms and Incentives to Innovate

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FRINGE FIRMS AND INCENTIVES TO INNOVATE

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In some industries, the most innovative firms are the industry leaders. During the 1970s, for example, Kodak routinely introduced amateur photography products a step ahead of its rivals.[1] In other industries, the fringe producers are typically first to introduce new and improved products or production processes.[2] "Royal Crown, not Coke or Pepsi, produced the first diet cola, the first caffeine-free soft drinks, and the first soft drinks in cans."[3]

Neither economic theory nor empirical economic studies offers a general rule as to whether the leading firms or the fringe will be the main source of innovation in most industries. Yet the stakes are high in understanding the connection between market structure and innovation. Two decades of slow U.S. productivity growth have heightened interest in public policies that promote innovation. Although the source of the productivity problem is disputed—insufficient research and development (R&D) may or may not be a leading cause[4]—innovation likely occurs less frequently than would be socially optimal given the costs and

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[1] Kodak's actions spawned a monopolization suit by a frustrated fringe rival. Berkey Photo, Inc. v. Eastman Kodak, Co., 603 F.2d 263 (2d Cir. 1979), *cert. denied*, 444 U.S. 1093 (1980).

[2] *See* F.M. SCHERER & DAVID ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 653 (3d ed. 1990) ("new entrants without a commitment to accepted technologies have been responsible for a substantial share of the really revolutionary new industrial products and processes").

[3] *The Innovative Royal Crown*, N.Y. TIMES, Jan. 14, 1984, at 27.

[4] For discussions of the productivity problem, its importance, and its sources, see MARTIN N. BAILY & ALOK K. CHAKRABARTI, INNOVATION AND THE PRODUCTIVITY CRISIS (1988); WILLIAM BAUMOL ET AL., PRODUCTIVITY AND AMERICAN LEADERSHIP: THE LONG VIEW (1989); Zvi Griliches, *Productivity Puzzles and R&D: Another Nonexplanation*, 2 J. ECON. PERSP. 9 (1988).

opportunities of doing so.[5] In this environment, it is important that antitrust analysis reflect an understanding of the way industry structure may influence innovative effort.[6]

This article examines the circumstances under which fringe firms are more likely than leading firms to innovate aggressively. This inquiry is relevant to antitrust policy because many practices reviewed under the antitrust laws—including horizontal joint ventures or mergers involving large firms—can be understood in part as aiding the leading firms in oligopolistic industries relative to their fringe rivals.[7] While the classification of the firms in a market as leading or fringe can be difficult, the core concepts are clear.[8] Leading firms generally have larger market shares than their fringe rivals (regardless of their absolute size or their relative position in other markets). Leading firms will often recognize that their output decisions will affect the price they receive; fringe firms are more likely to act as price-takers. Fringe firms are likely to lack some of the advantages that the leading firms possess, such as reputation for quality, access to inexpensive or high quality inputs, or effective distribution.

The significance of fringe innovation is highlighted in Part I by a case study of the U.S. automobile market during the 1970s. During that decade two Japanese automakers with little prior U.S. presence, Toyota and Nissan, successfully penetrated the market by innovating more rapidly than the leading domestic automakers.[9] Part II frames the question of identifying when fringe firms can be expected to be the more innova-

[5] Studies of the return to investment in research and development invariably find that the return to society is more than double the return to the firms making the investment, suggesting that private markets provide less than the optimal incentive to innovate. *E.g.*, Edwin Mansfield, *Microeconomics of Technological Innovation*, *in* TECHNOLOGY AND GLOBAL INDUSTRY 311 (Bruce R. Guile & Harvey Brooks eds., 1987); Jeffrey Bernstein & M. Ishaq Nadiri, *Interindustry R&D Spillovers, Rates of Return, and Production in High-Tech Industries*, 78 AM. ECON. REV. 429 (1988).

[6] Not every policy that encourages research and development is socially beneficial. "Patent races," in which potential innovators in effect fish in a "common pool," can generate overinvestment in R&D, wasteful duplication of R&D effort, or skew research effort away from the most valuable opportunities by causing overinvestment in certain fields. Jennifer Reinganum, *The Timing of Innovation: Research, Development and Diffusion*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 861 (Richard Schmalensee & Robert D. Willig eds., 1989). Antitrust rules that encourage R&D are unlikely to have such perverse effects, however.

[7] Many unilateral practices of dominant firms and many vertical agreements can also be conceptualized in part as aiding leading firms relative to their fringe rivals.

[8] These concepts generalize the familiar economic models of a dominant firm with a competitive fringe, and a Stackelberg leader with followers. *E.g.*, SCHERER & ROSS, *supra* note 2, at 221–26.

[9] To learn from Toyota's success, General Motors (GM) negotiated a joint venture with Toyota that was the subject of an intensive review by the Federal Trade Commission. General Motors Corp., 103 F.T.C. 374 (1984).

tive in terms of an entry-deterrence game between leading firms and fringe firms. This perspective highlights several factors that encourage leading firms to accommodate fringe innovation rather than deter it. These factors likely led the fringe automakers to innovate more aggressively than the Big Three during the 1970s. The final section identifies one lesson for antitrust enforcers and courts: a case-by-case analysis emphasizing the specific factors affecting firm R&D investments in individual industries is important for understanding the influence of changes in market structure on innovation.

I. JAPANESE AUTOMOBILES IN THE 1970S: MARKET PENETRATION THROUGH RAPID INNOVATION[10]

Which automobile producers benefited most from the demand shift to small cars during the 1970s?[11] Not the Big Three—General Motors (GM), Ford and Chrysler—despite their strong brand names, dealer networks, and installed base.[12] And not Volkswagen (VW), even though the Beetle had previously dominated the subcompact niche with a superior product.[13]

The big winners in the United States were two fringe sellers: Nissan (then called Datsun) and Toyota. As the decade began, they had tiny market shares and sold low quality products.[14] But over the 1970s, these firms innovated explosively. As a result, Japanese auto manufacturers experienced productivity increases between 1970 and 1980 at more than triple the rate of manufacturers in the United States, Canada, and Ger-

[10] Unless otherwise noted, automobile industry statistics are taken from *Ward's Automotive Yearbook* and automobile model quality information comes from *Consumer Reports*.

[11] The OPEC oil price shocks of 1974 and 1979 led to higher gasoline prices and recessions. As a result, automobile demand shifted away from midsize and large cars, toward more fuel-efficient compact and subcompact automobiles.

[12] At the end of the 1960s, these three firms accounted for roughly 87% of new cars sold in the United States.

[13] At the end of the 1960s, Volkswagen was America's fourth major automobile company, accounting for 6% of new car sales. Its sales were double those of American Motors, the largest firm in the domestic fringe. *Consumer Reports* considered the 1969 VW Beetle the "top choice for a second car" because it was "the most economical new car on the U.S. market, considering purchase price, operating costs and resale value." Although this product was strongly competitive, substantial room for improvement remained. The consumer magazine complained about the Beetle's "mediocre ride, wind sensitivity, limited accommodations, and poor heater design."

[14] At its U.S. debut in 1970, *Consumer Reports* judged the Toyota Corolla "Not Acceptable" due to inadequate braking, and complained that the car rode and handled badly. As late as April 1974, on the eve of the first OPEC oil shock, the four highest rated subcompact models were European and American, not Japanese: the Fiat 128, AMC Gremlin, Opel Manta, and Ford Mustang.

many.[15] Year after year, Nissan and Toyota improved quality and lowered the price of their subcompact models.[16] As the Japanese producers found success in the market with high quality and low priced products,[17] consumers were also winners.

The Big Three and Volkswagen could not keep pace. The U.S. firms contested the subcompact segment in the early and mid-1970s with models such as Ford's Maverick, Pinto, and Mustang, and Chevrolet's Vega and Chevette. Initially, these models were comparable in price and quality to those from Nissan and Toyota. But by 1978, domestically produced subcompacts were not close in quality to comparably priced imports such as the Datsun B210 and Toyota Corolla.[18] Volkswagen did not improve the Beetle during the 1970s, and that model fell behind in relative quality.[19] Volkswagen instead introduced a new model, the Rabbit, in 1975. Yet while the Rabbit was an engineering marvel,[20] it was no lower than the middle of the pack in price.

The Japanese firms' success is commonly attributed to unique, distinctively Japanese innovations in the production process.[21] Although there

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[15] MELVYN FUSS & LEONARD WAVERMAN, COSTS AND PRODUCTIVITY IN AUTOMOBILE PRODUCTION: THE CHALLENGE OF JAPANESE EFFICIENCY 137 (1992). Most of the Japanese productivity growth came from technical change rather than the exploitation of scale economies. *Id.* In 1970, U.S. auto producers were 10% more efficient technically than Japanese firms, but by 1975 the Japanese firms were 5% more efficient and by 1980 the Japanese advantage had increased to more than 20%. *Id.* at 218–22. The dramatic productivity gains at Nissan and Toyota relative to their U.S. competitors are described in MICHAEL A. CUSUMANO, THE JAPANESE AUTOMOBILE INDUSTRY 196–217 (1985).

[16] The Toyota Corolla, deemed "Not Acceptable" by *Consumer Reports* in 1970, was transformed in one year into a "handy car for around town." In 1971, the model ranked in the middle of its class in quality. Three years later it was still average in quality, but it had become the cheapest car in its class. The 1976 Corolla was among the highest subcompacts in product quality and also among the lowest priced. Nissan also improved its models, though not as dramatically.

[17] Toyota's U.S. sales surpassed Volkswagen's for the first time in 1975, the very year VW introduced a new subcompact model, the Rabbit. Nissan passed VW in 1976. By 1980, Volkswagen's sales were half those of Nissan and Toyota, and Honda had become the third highest selling subcompact brand.

[18] The Big Three's captive imports, such as the Buick Opel, Dodge Colt, and Ford Fiesta, kept better pace in quality than domestically-manufactured models.

[19] By 1976, several rival subcompacts models, including the Toyota Corolla and Datsun B210, underpriced the Beetle. At the same time, *Consumer Reports* complained that the Beetle had been "left behind in automotive technology."

[20] The 1976 Rabbit was ranked by *Consumer Reports* as the highest quality car in its class.

[21] *E.g.*, JAMES P. WOMACK ET AL., THE MACHINE THAT CHANGED THE WORLD 49, 79–82 (1990). This widely read study develops the notion of "lean production" (as distinguished from "mass production") in part by contrasting the performance of Toyota with General Motors. It does not observe, however, that Nissan's Japanese plants, which have been nearly as productive as Toyota's, are based on an approach to the production process more similar to that employed by GM.

is some truth in this perspective—Toyota and Nissan indeed found ways to improve quality and lower price more rapidly than their rivals, and these improvements have spread to other firms, industries, and continents—this view is misleading because Toyota and Nissan did not innovate in the same way.[22] To be sure, Toyota developed and implemented many of the innovations in the production process now considered distinctively Japanese, such as short production cycles, small production lots, and the just-in-time inventory system. But Nissan improved quality and lowered cost and price just as rapidly while organizing production the way the Big Three did, with long production runs. Unlike the Big Three during the 1970s, Nissan perfected the approach to production employed by U.S. automakers by adopting well-known inventory and quality control methods such as computerized scheduling and total quality control.[23] As the remainder of this section will demonstrate in detail, Nissan's and Toyota's success derived not from a common Japanese innovation in the production process but rather because fringe producers had a greater incentive to innovate than the leading firms in the U.S. automobile oligopoly of the 1970s.

A. NISSAN AND THE "AMERICAN" PRODUCTION PROCESS

It is useful to begin by distinguishing between two different approaches to the production process, which will be termed "American" and "Japanese."[24] The American approach is driven by the desire to achieve econo-

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[22] The description of Toyota's and Nissan's production processes during the 1970s relies throughout on MICHAEL A. CUSUMANO, *supra* note 15. Cusumano highlights differences in production strategy between the firms, and these differences suggest the distinction between American and Japanese production processes made below.

Although the text emphasizes ways in which Nissan's approach to production was more similar to that of the Big Three than to Toyota, on some dimensions the two Japanese firms were more similar to each other than to their U.S. rivals. The greatest similarity may have involved labor relations in the workplace. *See* DAVID I. LEVINE, REINVENTING THE WORKPLACE: HOW BUSINESS AND EMPLOYEES CAN BOTH WIN (forthcoming 1995); CUSUMANO, *supra* note 15, at 137. Both Japanese firms also adopted modern quality control strategies in advance of their U.S. rivals.

[23] In the past decade, however, the Big Three have improved their production processes in ways similar to those adopted by their Japanese rivals.

[24] This distinction is made for analytic clarity. Any actual production system, including those of Nissan and Toyota, combines elements of both models. Differences in inventory management between U.S. and Japanese firms are clarified in David F. Pyke & Morris A. Cohen, *Push and Pull in Manufacturing and Distribution Systems*, 9 J. OPERATIONS MGMT. 24 (1990). For discussions of other differences between American and Japanese firms, see Masahiko Aoki, *Toward an Economic Model of the Japanese Firm*, 28 J. ECON. L. 1 (1990); Debra J. Aron & Pau Olivella, *Bonuses and Penalty Schemes as Equilibrium Incentive Devices, with Application to Manufacturing Systems*, 10 J.L. ECON. & ORG. 1, 18–21 (1994); LEVINE, *supra* note 22.

mies of scale.[25] By achieving long runs of machine tools and other production equipment, the firm can minimize changeover costs (setup costs and the costs of retraining workers for new jobs), and so lower its average production costs.

To optimize the American production process, a firm must work to increase production speed. The faster that production takes place, the lower the labor and materials holding costs required to make a given level of output, so the lower the average production cost to the firm.

Anything that interrupts planned production runs destroys the source of the anticipated economies. Accordingly, a firm with an American production process must ensure that production operations involving long runs are never short of material to work on. To optimize the American system, a firm must in consequence work to improve three aspects of its manufacturing operation.

First, the firm must build an inventory of raw materials and work in process, and "push" completed work on to the next work station rather than stop a production run if completed work builds up. Yet holding inventory is costly, as it ties up working capital. Hence, the firm must plan its operations to manage inventory and work in process levels carefully.

Second, a firm with an American production process must hold excess production capacity upstream to minimize the danger that machine downtime for feed operations will interrupt the flow of work in process to later operations involving long production runs. Because holding redundant, idle capacity is costly, the firm must assess the risk of equipment malfunction when it invests in machinery and plans the arrangement of work in the production process.

Finally, quality problems in the broadest sense—design errors, production mistakes, defective components, and poor raw materials—are expensive for any firm. But they are particularly costly for a firm geared to achieve scale economies because they create a significant risk of ruining a large amount of output before detection.[26] If the output of a long production run must be scrapped, the anticipated scale economies disap-

[25] *See* Armen Alchian, *Costs and Outputs*, *in* THE ALLOCATION OF ECONOMIC RESOURCES 23–40 (Moses Abramovitz et al. eds., 1959). For a description of an American production process in automobiles that argues that scale economies were far from exhausted in stamping operations for auto body manufacturing in the early 1970s, see John McGee, *Economies of Size in Auto Body Manufacture*, 17 J.L. & ECON. 239 (1974).

[26] Defects that arrive randomly by the production "batch" are more costly for a firm employing large batches in production than for a firm employing small batches.

pear. In consequence, a firm seeking to optimize the American production process must work to improve its quality control.[27]

Nissan organized its production operations mainly as an American process.[28] The central difference between its production strategy and that of the Big Three domestic U.S. producers during the 1970s was not in the approach to production. Rather, the difference was in Nissan's greater willingness to adopt improvements to the American process that speeded production and addressed the key problems of inventory management, production scheduling, and quality control. In optimizing the American production process, Nissan adopted production innovations known to the Big Three but not accepted as quickly or enthusiastically by the U.S. firms.

To speed production, Nissan became a leader in automation. It adopted automated production and conveyance equipment on assembly lines in the 1950s and early 1960s and automated welding machinery (robotics) in the mid-1960s.[29] To lower inventories, Nissan became a leader in the use of computerized scheduling.[30] By the end of the 1960s, it had computerized all phases of production control.[31] In 1971 the firm extended computerized scheduling upstream to the procurement of materials and components and downstream to the ordering of final products by dealers and the delivery of finished products to them.[32] The resulting improvements in production coordination more than halved Nissan's average lead time to produce an automobile.[33]

To control quality, Nissan embraced the statistical methods popularized by W. Edwards Deming and Joseph Juran.[34] These methods involved

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[27] *Cf.* R.U. Ayres, *CIM: A Challenge to Technology Management*, 7 INT'L J. TECH. MGMT. 17, 18–19 (Special Issue on Strengthening Corporate and National Competitiveness Through Technology 1992) (a firm with an American production process may be able to improve quality at less expense than a firm with a Japanese process because the latter approach adds complexity).

[28] Nissan learned modern manufacturing by licensing, in 1952, the rights to assemble from knock-down sets a British automobile designed by Austin. Although it weaned itself off Austin's support in less than a decade, by modifying the Austin design and production process and substituting Japanese parts and machine tools for imported components, Nissan preserved an American production process based on the achievement of scale economies. *See* CUSUMANO, *supra* note 15, at 8–11, 97–108; *cf.* Jerome B. Cohen, *Private Point Four in Japan*, FORTUNE, April 1953, at 148 (Japanese firms systematically employed joint ventures with U.S. firms to acquire modern know-how).

[29] CUSUMANO, *supra* note 15, at 227–30, 307–12.

[30] *Id.* at 296, 316.

[31] *Id.* at 227.

[32] *Id.* at 308, 317.

[33] *Id.* at 317.

[34] *Id.* at 320–24.

more than the use of statistical sampling and inspection to identify quality problems: they encouraged firms to modify production equipment and the manufacturing process in order to reduce defect levels by increasing product uniformity.[35] Around 1960, quality control engineers took this idea one step further: they came to see their primary task as preventing quality problems rather than screening out defective products, and so developed the concept of "total quality control."[36] Firms such as Nissan learned to work with their customers to modify products to solve problems or improve product design.[37] They learned to insist on defect-free materials and components and to encourage their suppliers to institute their own quality control programs.[38] Firms came to rely upon shop floor workers to help identify opportunities for product and process improvements,[39] rather than merely delegating quality control to a separate engineering staff.[40]

B. TOYOTA AND THE "JAPANESE" PRODUCTION PROCESS[41]

If the American production process centers around the achievement of economies of scale, the Japanese process is organized around the achievement of production flexibility. With flexibility, firms can quickly and cheaply alter existing products and the production process, add new

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[35] Japanese firms adopting Deming's ideas in the mid-1950s reported large, rapid increases in productivity. DAVID HALBERSTAM, THE RECKONING 316 (1986). Nissan's adoption of automated production machinery and customized machine tools may have facilitated the company's use of these techniques.

[36] CUSUMANO, *supra* note 15, at 324–42. These ideas were developed mainly by Americans, especially Armand V. Feigenbaum of General Electric, along with Deming and Juran. But these ideas were largely ignored in the U.S. while studied carefully in Japan. For a journalistic treatment highlighting Deming's contribution, see ANDREA GABOR, THE MAN WHO DISCOVERED QUALITY (1990). For a description of total quality management that emphasizes employer involvement, see LEVINE, *supra* note 22, at ch. 1.A.

[37] CUSUMANO, *supra* note 15, at 330–31.

[38] *Id.* at 245, 258, 377.

[39] As early as the mid-1950s, Japanese automakers gave their employees the authority to stop assembly lines when they noticed defects or errors. *Id.* at 328.

[40] In 1960, as a result of its efforts to improve quality in the years before it successfully penetrated the U.S. small car market, Nissan won the Deming prize, awarded annually by the Japanese Union of Scientists and Engineers to a firm that developed an institutional commitment to quality control. *Id.* at 350. Toyota won the Deming prize five years later, consistent with the view that improved quality control may be more critical for a firm that relies on an American production process than for one that relies on a Japanese production process.

[41] *See generally* JAPAN MANAGEMENT ASS'N, KANBAN: JUST-IN-TIME AT TOYOTA (1989). For another example of a Japanese production process, in camera and copier manufacturing, see JAPAN MANAGEMENT ASS'N, CANON PRODUCTION SYSTEM (1987). Complementarities among the many aspects of the Japanese process are emphasized by Paul Milgrom & John Roberts, *The Economics of Modern Manufacturing: Technology, Strategy, and Organization*, 80 AM. ECON. REV. 511 (1990).

products, customize their products, or vary the output mix of existing products. These options facilitate firm efforts to meet changing buyer tastes and take advantage of opportunities to improve quality and lower cost. They also help multiproduct firms transfer their expertise in the process for producing one good to the manufacture of other products.[42]

To achieve production flexibility, Toyota modified its production process in ways antithetical to the American system. It employed short production cycles and small production lots.[43] It also designed a more flexible production process, as by making greater use of universal (rather than customized) machine tools.[44]

The Japanese production process gives up the ability to plan for long production runs in exchange for ease in instituting product and process modifications and the ability to achieve product variety inexpensively.[45] To optimize this production system, firms must work to minimize three potential problems. First, they must keep production setup times short; otherwise, costs can become astronomical. Accordingly, Toyota designed its production process for rapid setup modification. It developed ways of reducing machinery setup times, including completing preparations before the machines stopped, employing standardized parts across multiple setups, redesigning fasteners, training workers in setup modification, and redesigning stamping equipment to accept new dies in the right place without need for adjustment. Through such methods, Toyota shrank the time needed to change stamping dies from two or three hours before 1955 to fifteen minutes by 1962 and three minutes by 1971.[46]

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[42] Thus, production flexibility permits manufacturers to achieve scope economies in producing multiple products that can compensate in part for any loss of scale economies in producing individual products. Ayres, *supra* note 27, at 17, 20–21; *cf.* ALFRED D. CHANDLER, JR., SCALE AND SCOPE (1990) (stressing the importance of scope economies in modern manufacturing).

[43] In 1977, for example, Toyota produced most components made in stamping plants in lots equal to one day's supply, and changed dies three times per day. In contrast, U.S. and European manufacturers employing American production processes manufactured in lots equivalent to 10 or 30 days' supply and reset equipment every day or two. CUSUMANO, *supra* note 15, at 285.

[44] *Id.* at 66, 249.

[45] JAMES C. ABEGGLEN & GEORGE STALK, JR., KAISHA, THE JAPANESE CORPORATION 94 (Toyota goal of increasing product variety), 111 (increased ability to respond to changes in demand), 118 (strategic value of product line expansion) (1985); *see* WOMACK ET AL., *supra* note 21 at 64–65 (product variety at Toyota).

[46] CUSUMANO, *supra* note 15, at 284–87; *see Toyota-ism Means War on Waste*, ECONOMIST, May 30, 1987, Factory of the Future Survey, at 12–13 (methods of reducing setup times); *cf.* ABEGGLEN & STALK, *supra* note 45, at 96–97 (companies following Toyota's example have also concentrated on reducing setup times). Short setups also lower costs for a firm with an American production process, but the resulting cost reductions are less significant determinants of average costs than for a firm with a Japanese process. While Nissan also cut setup times dramatically, its times were consistently triple those of Toyota. CUSUMANO,

Second, a firm with a Japanese production process must avoid creating work in process unless it is confident that the production process will carry through to a finished good. Otherwise, product or process alterations made possible by production flexibility could lead to costly liquidations of inventories of partially completed work. To avoid this problem with production flexibility and keep inventory holding costs low, Toyota invented a "pull" inventory system—the "*kanban*" or "just-in-time" system—to replace the push system employed by firms using an American production process.[47] Under this system, earlier work is not authorized until it is demanded by a later production step, work in process is not created or improved without a guarantee that it is needed, and components from suppliers are delivered just before they are needed.[48] The just-in-time system operates with simple, decentralized coordination: a downstream process requiring more inputs merely orders more from the preceding production step, and these orders are quickly transmitted backwards when the earlier processes order inputs of their own.[49]

Third, to optimize the Japanese production process, a firm must work to identify product and process improvements frequently and implement them rapidly.[50] Only then will it obtain the benefits from production flexibility that compensate for the loss of scale economies. In part, this occurs automatically as a byproduct of the just-in-time inventory system. Just-in-time automatically helps the firm identify process improvements by directing attention to production bottlenecks.[51] If one production

supra note 15, at 284–87. As late as the early 1980s, by contrast, many U.S. and European manufacturers took hours to change dies. *Id.* Japanese manufacturers have also reduced the time required to retool entire factories for new models. While their U.S. rivals take months, they retool in days. *Motown's Struggle to Shift on the Fly*, BUS. WK., July 11, 1994, at 111–12.

[47] Toyota engineer Taiichi Ohno worked out the *kanban* approach to inventory management in the 1950s and 1960s. ABEGGLEN & STALK, *supra* note 45, at 93. Toyota insisted that its suppliers adopt it as well. CUSUMANO, *supra* note 15, at 298–99.

[48] ABEGGLEN & STALK, *supra* note 45, at 102–03. The just-in-time inventory system has difficulty accommodating unexpected variation in demand, especially when a large number of production steps occur in sequence. CUSUMANO, *supra* note 15, at 292; *cf.* ABEGGLEN & STALK, *supra* note 45, at 103—04, 110–11 (Toyota freezes production schedules for a week or month to ensure level production rates); *but cf. id.* at 111 (flexibility makes a Japanese production process more suitable to an environment with uncertain demand). Because Toyota was generally operating at full production capacity during the 1960s and 1970s, *id.* at 237, this problem was not serious.

[49] In contrast, complex and centralized coordination is required to minimize inventories while maximizing production runs in the American production process. Accordingly, Nissan embraced computerization in the 1960s and 1970s, while Toyota resisted it. *Id.* at 296–98.

[50] For this reason, the Japanese production process is not just an innovation in the process of manufacturing; it also represents an innovation in the process of innovation.

[51] RICHARD J. SCHONBERGER, JAPANESE MANUFACTURING TECHNIQUES 15 (1982).

step has trouble producing what is demanded of it in time, in sufficient quantities, or free of defects, that fact is quickly highlighted under just-in-time because the firm lacks a buffer stock of earlier production to draw down. Workers, engineers, and managers are thus led to consider changes in the production process or product design to address the bottleneck—improvements likely to have a high payoff in cost reduction—and those changes can readily be implemented within the system of flexible production.[52] Then attention will turn to the next bottleneck, and so a process of incremental cost reduction—a process of organizational learning termed "*kaizen*" (continuous improvement) in Japan—is institutionalized.[53]

Firms seeking to optimize the Japanese production system by taking advantage of the benefits of production flexibility also work to identify more product and production process innovations by investing in information.[54] Through market research and customer relations, they seek to identify desirable product modifications frequently.[55] They keep abreast of innovations adopted by their rivals, and work quickly to duplicate them. They work with suppliers to harmonize operations and identify process improvements that lower joint costs. They benchmark their production process against that of unrelated firms. While firms employing an American production system can also benefit from identifying valuable innovations, such information may often be used more efficiently by a firm with a Japanese production process.

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[52] For example, factories may alter shop floor layout to reduce materials handling. ABEGGLEN & STALK, *supra* note 45, at 98. Other examples are described in LEVINE, *supra* note 22, ch. II.A.

Changes to the production process that take the form of production line speedup rather than modifications in product design or production machinery run the risk of generating worker hostility, however. This has been the complaint of some U.S. unions about Japanese-run plants. MIKE PARKER & JANE SLAUGHTER, CHOOSING SIDES: UNIONS AND THE TEAM CONCEPT (1988).

[53] Although firms employing an American production process also obtain cost reductions from learning-by-doing, the rate of learning is likely accelerated in the Japanese production system because of this feature.

[54] *See What Makes Yoshio Invent*, ECONOMIST, Jan. 12, 1991, at 61 (free flow of information is critical to rapid new product development). To process this information, firms develop new organizational forms. *See Er. . .*, ECONOMIST, Sept. 8, 1990, at 76. To make use of this information, they develop ways of relating it to the firm's core competencies. *See Competing with Tomorrow*, ECONOMIST, May 12, 1990, at 65–66. For this reason, successful innovations tend to be closely related to firms' existing technological and marketing skills, and occur in product fields close to existing products. Giovanni Dosi, *Sources, Procedures, and Microeconomic Effects of Innovation*, 26 J. ECON. LIT. 1120, 1131 (1988).

[55] *See King Customer*, BUS. WK., Mar. 12, 1990, at 88, 89–90 (Japanese firms succeeded relative to U.S. firms through "assiduously uncovering and accommodating customer needs"). During the 1960s, Toyota was more aggressive than Nissan in modifying its product in order to please U.S. consumers. *Cf.* HALBERSTAM, *supra* note 35, at 428, 436–42 (Nissan's experience).

These information and innovation demands appear to encourage interfirm collaboration.[56] This trend is apparent in the automotive industry, where joint ventures have become commonplace—even spreading to firms with American production processes.[57] The highest profile ventures connect competitors in production or marketing, but other ventures among competitors involve R&D or the production of components.[58]

Once firms adopting a Japanese process identify desirable product and process modifications, they work to implement these improvements rapidly.[59] They seek to engineer products quickly and move new innovations rapidly from the drawing board to the production line.[60] These firms try to design products and the production process in ways that make it easy to accept improvements—such as modular product design and adaptable shop floor organization.[61]

C. THE AGILE MANUFACTURING SYNTHESIS

The Japanese production process did not fully displace the American production process in the automobile industry of the 1970s because, as Nissan's success demonstrates, improvements to the American produc-

[56] Much of this collaboration involves vertically-related firms, connecting firms with their suppliers or dealers. Joint ventures among competitors—which have historically generated the closest antitrust scrutiny—are also encouraged. Alliances among rivals, once rare, now seem common. *Holding Hands*, ECONOMIST, Mar. 27, 1993, Multinationals Survey, at 14. Firms making these alliances frequently report that they do so to speed the rate of innovation. *Id.* As new information and telecommunications networks are developed, those innovations will likely facilitate even wider and more frequent interfirm collaboration than now occurs. *Cf.* COUNCIL OF ECONOMIC ADVISERS, ECONOMIC BENEFITS OF THE ADMINISTRATION'S LEGISLATIVE PROPOSALS, June 14, 1994 (forecasting developments in telecommunications).

[57] *Spot the Difference*, ECONOMIST, Feb. 24, 1990, at 74.

[58] PETER F. COWLEY & JONATHAN D. IRONSTONE, MANAGING THE WORLD ECONOMY: THE CONSEQUENCES OF CORPORATE ALLIANCES 104–20 (1993). General Motors builds the Geo Prizm in a joint venture with Toyota and the Geo Metro in a joint venture with Suzuki. It also purchases the Geo Storm from Isuzu and the Geo Tracer from Suzuki. Ford owns a stake in Mazda, and Chrysler has been allied with Matsushita and Hyundai.

[59] The expansion of production processes based on flexibility may also lead to greater product variety—if innovative effort focuses on adding more products to serve narrow niches as well as improving existing products and processes.

[60] *See* Kim R. Clark et al., *Product Development in the World Auto Industry*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 729, 743–49 (Japanese firms exhibit short lead times in product development). Concurrent engineering, a contemporary approach to rapid product development, was invented in Japan. *A Smarter Way to Manufacture*, BUS. WK., Apr. 30, 1990, at 110–17.

[61] *At the Unstrain'd Mercy of Quality*, ECONOMIST, Apr. 21, 1990, at 82; THOMAS E. VOLLMAN ET AL., MANUFACTURING PLANNING AND CONTROL SYSTEMS 259–61 (2d ed. 1988). To accommodate such changes, these firms frequently cross-train workers. *Id.* at 243–45; ABEGGLEN & STALK, *supra* note 45, at 99; *cf. The Car Makers' Recovery Stakes*, ECONOMIST, Oct. 29, 1994, at 73 ("what now determines competitive advantage is the ability to design cars that are cheaper to build than those of competitors").

tion process conferred productivity advantages comparable to those obtained from a Japanese process. The "winning" production system may never be determined, moreover, because the two approaches to production are increasingly blurred with the development of a hybrid production system sometimes termed "agile manufacturing." Agile manufacturing is based upon flexible robots and computer-integrated manufacturing.[62]

Agile manufacturing promises to combine the best features of the American and Japanese systems.[63] When computer controlled machine tools and robots can quickly shift tasks without compromising speed, accuracy, and reliability, it may become possible to achieve the advantages of both long production runs and flexibility.[64] Plants will be able to assemble more than one product on the same production line simultaneously,[65] for example, and modify processes and products rapidly.[66]

In the automobile industry of the 1970s, the Japanese and the American production systems were more distinct than they appear today. Nissan and Toyota were both extremely innovative, especially in improving the production process. Because they improved fundamentally different production processes, their success cannot be attributed to a common set of innovations. Rather, as will be demonstrated in the next section, the two Japanese firms succeeded because U.S. market conditions gave these fringe producers stronger incentives to innovate than it gave the

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[62] R.U. Ayres, *supra* note 27, at 17, 22–23 (computer-integrated manufacturing is the next stage in industrial evolution). *The Challenge*, ECONOMIST, May 30, 1987, Factory of the Future Survey, at 1; F. Hiatt, *Japan Creating Mass-Produced Customization*, WASH. POST, Mar. 25, 1990, at A29; *Bodybuilding Without Tears*, ECONOMIST, Apr. 21, 1990, at 95–96; *cf.* John Holusha, *Industry Is Learning to Love Agility*, N.Y. TIMES, May 25, 1994, at D1 (highlighting organizational innovations that facilitate agile manufacturing).

[63] Automation does not automatically confer these advantages. A firm that automates an inefficient production process will not be as successful as one that automates an efficient process. Accordingly, firms seeking to adopt or modify an agile manufacturing system must first optimize their American or Japanese production process, then automate it. In consequence, pilot production runs using an American or Japanese process, during which process optimization can occur, will likely remain an essential adjunct to agile manufacturing. *Cf.* LEVINE, *supra* note 22, ch. II.A (describing a pilot team at Toyota).

[64] *What Would Henry Think?* ECONOMIST, May 30, 1987, Factory of the Future Survey, at 4; *Manufacturing à la Carte: Agile Assembly Lines, Faster Development Cycles*, IEEE SPECTRUM, Sept. 1993, at 24; *see* A.C. Boynton et al., *New Competitive Strategies: Challenges to Organizations and Information Technology*, 32 IBM SYS. J. 40 (1993); *cf. Putting It All Together*, ECONOMIST, Mar. 5, 1994, at 13–15 (describing ways of arranging a manufacturing facility employing robots to achieve flexibility and efficiency).

[65] Although Toyota experimented with mixed assembly in the 1950s, CUSUMANO, *supra* note 15, at 281–84, robotics makes this approach more attractive and more common today.

[66] *Retooling with Software*, AUTOMOTIVE ENG'G, July 1991, at 78 (describing Nissan's "Intelligent Body Assembly System").

leading firms: General Motors, Ford, Chrysler, and the leading subcompact producer, Volkswagen.

II. FRINGE INCENTIVES TO INNOVATE

Leading firms can often make R&D investments to deter fringe firms from undertaking aggressive innovation efforts.[67] This makes the distinction between leading and fringe firms important to understanding incentives to innovate.

Leading firms in industries in which innovation is important are confronted with a strategic choice between deterrence and accommodation. If the leading firms choose deterrence, they will likely become the primary sources of industry innovation; the fringe firms will generally do no more than imitate successful new products or processes of the leading firms. If the leading firms instead choose accommodation, the fringe will likely become the primary source of industry innovation.[68] Nissan and Toyota were encouraged to innovate during the 1970s because the Big Three automakers likely found it more profitable to adopt an accommodation strategy in the market for small cars than a deterrence strategy.[69]

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[67] The discussion in the text emphasizes the incentives to innovate arising out of the way R&D investments affect the rivalry between leading firms and fringe firms. *See* Michael Katz & Carl Shapiro, *R&D Rivalry with Licensing or Imitation*, 77 AM. ECON. REV. 402 (1987) (describing potential preemptive effect of innovation); Richard Gilbert, *Mobility Barriers*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 475 (Richard Schmalensee & Robert D. Willig eds., 1989) (describing strategic entry deterrence generally). A host of non-strategic factors not highlighted in the text, including the direct effect of cost reductions or new products on profits, the appropriability of new ideas by their innovators, and the nature of buyer demand, as well as differences among leading and fringe firms, are also important in explaining firm incentives to innovate. *See generally* Jennifer Reinganum, *supra* note 6 (survey of economic literature on innovation incentives); JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION 387 (1988) (same); Wesley M. Cohen & Richard C. Levin, *Empirical Studies of Innovation and Market Structure*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1059 (Richard Schmalensee & Robert D. Willig eds., 1989) (empirical evidence surveyed). This article does not address the effects on aggregate welfare of government policies that might change the relative incentives of fringe and leading firms to innovate.

[68] Here the fringe firms can be thought of as "mavericks" that innovate aggressively when the leading firms do not. On the role of mavericks in constraining coordinated oligopoly pricing in product markets, see Jonathan B. Baker, *Two Sherman Act Section 1 Dilemmas: Parallel Pricing, the Oligopoly Problem, and Contemporary Economic Theory*, 38 ANTITRUST BULL. 143, 199–207 (1993).

[69] It is unconvincing to attribute the rapid productivity growth of Japanese automakers in the 1970s instead to the relatively higher cash flow of Japanese automobile manufacturers compared with U.S. automakers during the oil shock decade; *but cf.* Bruce Greenwald et al., Imperfect Capital Markets and Productivity Growth (unpublished manuscript, April 14, 1992) (financial constraints led U.S. automakers to reduce R&D expenditures during the 1970s, despite the incentive to increase R&D arguably created by the oil shocks). Assuming, in sympathy with this theory, that internal finance was a lower cost method of funding R&D for U.S. firms than borrowing in the capital markets, the theory nevertheless

The leading firms may seek to deter fringe innovation by investing heavily in R&D. With an active research capability, the leading firms can expect to imitate fringe innovations rapidly, and so make it unlikely that a fringe producer will be able to benefit greatly from introducing new products or processes.[70] Recognizing this, the fringe will find aggressive efforts to pursue new ideas an unattractive strategy.

An active leading firm R&D effort does more than deter the fringe: with this strategy, the leading firms are likely to bring new ideas rapidly to market themselves, before fringe firms can do so. The leading firms will become the primary source of new products, and the fringe will find it more profitable to imitate proven leading firm innovations than to seek to innovate first.[71]

Yet a leading firm deterrence strategy is costly; it can involve substantial investments in R&D and it runs the risk of wasting those expenditures if efforts to innovate do not pan out. To avoid these costs, the leading firms may instead choose to accommodate fringe entry, rather than seeking to deter it. Then the fringe is likely to innovate first and over time grow in significance. In contrast with the consequences of leading firm deterrence, here the leading firms will allow their market dominance to erode. But by avoiding the costs of deterrence, they will earn greater profits in the short term that may more than make up for reduced long-term profits.[72]

has difficulty explaining why Japanese automakers also increased productivity more rapidly than the Big Three before the oil shocks created the alleged cash flow constraints. *See* CUSUMANO, *supra* note 15, at 199.

[70] R&D investments are typically sunk expenditures, making strategic commitments such as this possible. The discussion in the text assumes that additional R&D investments make the leading firms "tougher" (more likely to match fringe innovation quickly). In the "animal" language proposed by Fudenberg and Tirole to describe business strategies, the leading firms will in consequence adopt either a "top dog" strategy to deter the fringe by appearing aggressive, or a "puppy dog" strategy that accommodates the fringe while appearing inoffensive. *See* Gilbert, *supra* note 67, at 509–10; *cf.* SCHERER & ROSS, *supra* note 2, at 635 (describing the "frequently observed tendency for market dominating firms to be slow in developing important new products, but to roar back like tigers when smaller rivals—often new entrants with no historical market share at all—challenge their dominance").

[71] *See* Gilbert, *supra* note 67, at 510 (circumstances under which an incumbent overinvests to deter entry); Richard Gilbert & David Newbery, *Preemptive Patenting and the Persistence of Monopoly*, 72 AM. ECON. REV. 514 (1982) (a firm with monopoly power has an incentive to maintain that power by developing new technologies before potential competitors); *cf.* SCHERER & ROSS, *supra* note 2, at 654 (describing cases in which "the threat of entry through innovation by a newcomer stimulated existing members to pursue well-known technical possibilities more aggressively.")

[72] *See* Jennifer Reinganum, *Uncertain Innovation and the Persistence of Monopoly*, 73 AM. ECON. REV. 741 (1983); Gilbert, *supra* note 67, at 510 (conditions under which an incumbent accommodates entry); Jennifer Reinganum, *Innovation and Industry Evolution*, 100 Q.J. ECON. 81 (1985).

A number of factors are likely to encourage leading firm accommodation of aggressive fringe research and development, and thus lead to a market in which fringe firms are the more innovative.[73] First, if leading firm innovation imposes costs beyond the direct expenditures on R&D that fringe innovation does not impose, so that deterrence is more expensive than accommodation, the leading firms are more likely to prefer accommodation.[74] The most notable indirect costs of developing new products or processes involve a reduction in the value of firm capital devoted to old products or processes—a cost often termed "cannibalization." For this factor to favor leading firm accommodation, leading firm innovation must impose greater indirect costs on the leading firms than would innovation by the fringe.

This observation was likely important in explaining the accommodation strategy of the Big Three automakers in the U.S. automobile market during the 1970s. The Big Three producers recognized that if they introduced an attractive subcompact model, many customers would switch away from their more profitable larger car models. The value of Big Three capital devoted to midsize cars would fall. But if a new subcompact were instead introduced by Japanese automakers, the substitution away from the Big Three's larger models and thus the indirect loss to the Big Three would be less because of product differentiation. A Big Three subcompact would be perceived as a closer substitute than a Japanese subcompact for a Big Three midsize car because the two Big Three models would share in brand reputation and dealer network.[75]

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[73] These are not the only relevant factors, but they are probably the most important in explaining the Big Three's decision to accommodate fringe innovation during the 1970s. *Cf.* SCHERER & ROSS, *supra* note 2, at 636, 637 n.63 (a dominant firm will be "more inclined to preempt than lag" if a laggard can lower costs by observing and avoiding first movers' false technical starts, if small interlopers initially penetrate the market only slowly, the more perfect patent protection is, the more the innovation threatens the dominant firm's rents in existing markets, the less uncertain R&D completion time is, the less likely licensing of the challenger's technology is, and the less likely multiple challenges are); WILLIAM BAUMOL, ENTREPRENEURSHIP, MANAGEMENT, AND THE STRUCTURE OF PAYOFFS 151–52 (1993) (factors encouraging a firm to become an "original innovator" rather than an imitator include a proliferation of prospective innovators, high costs of imitation imposed by innovator patents, long lifetime of innovator's product, low risk undertaken by innovator, and low spillovers of new ideas from innovator to imitators).

[74] *See* Reinganum, *Uncertain Innovation*, *supra* note 72; *cf.* Katz & Shapiro, *supra* note 67 (significance of "stand alone" innovation incentives).

[75] Nor would the Japanese automakers likely increase the scale or scope of their entry to the point where the indirect cost to the Big Three is the same as would be generated were the Big Three to introduce subcompact models. The Big Three's advantages in brand reputation and distribution, perhaps combined with decreasing returns to scale in production and distribution, effectively confronted the Japanese firms with a rising marginal cost of sales expansion, limiting for a time the practical extent of their diversion of Big Three sales. *Cf.* Judith Gelman & Steven Salop, *Judo Economics: Capacity Limitation and*

Thus, the prospect of a greater capital loss from Big Three entry than from fringe entry likely discouraged aggressive Big Three pursuit of the subcompact segment.

Second, leading firms will tend to prefer accommodation to deterrence when the ability of the fringe to expand, even with an attractive innovation, is limited.[76] In this case, the benefits of the deterrence strategy may be low relative to the costs. The leading firms may reasonably believe this when disadvantages like inferior distribution or low reputation for quality are likely to limit the rate of sales growth of an entrant, even if the entrant employs a lower cost process or sells an improved product. The leading firms may also expect that the fringe's ability to profit from an innovation will be limited when likely innovations are minor rather than drastic (not essential to survival in the industry), or when the leading firms would reasonably expect to imitate fringe innovations within a reasonable time even absent R&D expenditures on deterrence.[77]

This factor is also likely important in explaining the accommodation behavior of the Big Three automakers during the 1970s. The Big Three's strong dealer networks and brand reputations then conferred a substantial advantage relative to Volkswagen, and there was no reason to think that Japanese entrants would have greater market success than VW. And if fringe producers came up with product or process improvements, the Big Three, with all these advantages, would reasonably expect to recapture the market through imitation.[78] Even in retrospect, this reconstructed calculation does not appear entirely off the mark: despite the surprising success of the Japanese firms' penetration of the U.S. automobile market in the 1970s, General Motors continues to account for the largest share of automobile sales in the United States.

Coupon Competition, 14 BELL J. ECON. 315 (1983) (entrant induces incumbent accommodation by committing to limited entry).

[76] *Cf.* Richard Gilbert, *Pre-Emptive Competition*, *in* NEW DEVELOPMENTS IN THE ANALYSIS OF MARKET STRUCTURE 120 (Mathewson & Stiglitz eds., 1986) (if entrants would be small, incumbent firms are better off allowing entry, even if deterrence is feasible).

[77] Katz & Shapiro, *supra* note 67; *cf.* Ralph Landau & Nathan Rosenberg, *Innovation in the Chemical Processing Industries*, *in* NAT'L ACADEMY OF ENGINEERING, TECHNOLOGY & ECONOMICS 107, 111–14 (1991).

[78] The Big Three had used an imitation strategy successfully in the previous decade against a U.S. fringe, including American Motors, that had been successful for a time producing and selling compact cars. When subcompacts were introduced in the 1970s, the Big Three sought to repeat that success. Henry Ford II reportedly declared that the Big Three's new small cars would "drive the Japanese back to the sea." John E. Kwoka, *International Joint Venture: General Motors and Toyota*, *in* THE ANTITRUST REVOLUTION 48 (John Kwoka & Lawrence White eds., 1989) (quoting a paraphrase reported by the *Wall Street Journal*).

Risk aversion is a third factor that may encourage leading firm accommodation rather than deterrence.[79] R&D is risky. The likely R&D approaches may fail technically, new processes may not work, and new products may be marketplace failures. The status quo plausibly minimizes risk for the leading firms: they typically have a successful production and distribution technology. If risks of innovation failure are high, and the leading firms are risk averse, they have an incentive not to innovate first, even if a new technology, approach, or product has a greater expected return than the existing products or processes. Instead, they may benefit from waiting until successful new ideas are proven elsewhere before seeking to imitate them.

This factor may have played a role in the Big Three's incentive not to introduce compact car models aggressively in the 1970s. The investment in developing small cars was risky because of uncertainties about the stability of the OPEC oil cartel, the most important source of the demand shift favoring small cars. Although it actually took a dozen years for oil prices to return (in real terms) to their pre-OPEC levels, the Big Three might reasonably have considered it possible that the oil shocks would last only a couple years.[80]

Finally, the leading firms are more likely to prefer accommodation to deterrence when their oligopoly interaction is coordinated.[81] Coordinating oligopolists must take care to avoid reaching an agreement and so violating the antitrust laws.[82] In terms of price and output decisions, this constraint likely restricts the feasible set of coordinated arrangements to those consistent with a simple focal rule—such as outcomes reached

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[79] *See* Gilbert & Newbery, *supra* note 71, at 571 (risk aversion reduces incentives for preemptive innovation).

[80] This factor may also explain the decision by integrated U.S. steelmakers to delay adopting then-innovative basic oxygen furnace technology after World War II. *See* Sharon Oster, *The Diffusion of Innovation Among Steel Firms: The Basic Oxygen Furnace*, 13 BELL J. ECON. 45 (1982). European and Japanese steelmakers rebuilding from the ground up tended to chose the new technology rather than the older open hearth technology employed by the U.S. mills. But a U.S. producer could reasonably decide to wait before switching, until the cost savings and quality potential of the new technology had been proven. Thus, the U.S. steelmakers did not switch until a decade after European and Japanese firms had demonstrated the success of the new technology. A similar microeconomic story may explain the international "convergence" of productivity levels in a number of industries. *See* BAUMOL ET AL., *supra* note 4.

[81] Oligopoly behavior is coordinated when, in repeated interactions, firm strategies depend on history. *See generally* Baker, *supra* note 68, at 156 n.22, 195–96.

[82] Behavior may be coordinated without the firms violating the antitrust laws through tacit or express collusion. The antitrust laws do not prohibit supracompetitive prices or coordinated behavior per se; they prohibit coordination reached through process of negotiation and the exchange of mutual assurances of carrying through the negotiated consensus. *See generally id.* at 179.

by altering all prices by a common percentage or by avoiding solicitation of customers historically served by rivals.[83]

If a coordinated innovation strategy is constrained to follow self-evident rules, coordinated accommodation of fringe innovation may be more likely than coordinated deterrence. A coordinated strategy of leading firm accommodation can often plausibly be established without negotiation, and compliance with it readily assured. In contrast, focal rules for a coordinated strategy of deterring fringe innovation through preemptive leading firm R&D may be more difficult for the firms to identify, because the results of research and development activity are uncertain. The greater difficulty of coordinating deterrence may have encouraged the Big Three automobile oligopolists to adopt a fringe innovation accommodation strategy during the 1970s.

III. ON MARKET STRUCTURE AND INDUSTRY INNOVATION

This article has identified a number of factors that affect the relative incentives of fringe firms and leading firms to innovate. Other aspects of market structure also influence investments in R&D and the prospects for innovation. Most important, the economic literature on the influence of market structure on innovation has emphasized a complementary issue: whether seller concentration encourages or discourages industry innovation. Yet, as with the differing innovation incentives of fringe and leading firms, the theoretical and empirical studies of the influence of seller concentration on innovation have not led to the identification of a general rule applicable to most industries.

Two competing sets of theories, each associated with a famous economist, address whether a product market monopolist will innovate more or less than firms in a competitive industry.[84] Kenneth Arrow demonstrated that a monopolist may have less incentive to innovate than competitors because a monopolist may have more to lose. A monopolist could spend a great deal of money to lower cost, improve quality, or add a product line only to find that it does not get much additional business as a result—because, unlike a competitor, it already has most of the business there is to get.[85] Joseph Schumpeter had previously highlighted

[83] *Id.* at 162–69.

[84] For arguments on both sides of the Arrow vs. Schumpeter "debate," see Richard Gilbert & Steven Sunshine, *Incorporating Dynamic Efficiency Concerns in Merger Analysis: The Use of Innovation Markets*, *supra* this issue, 63 ANTITRUST L.J. 569 (1995); WILLIAM L. BALDWIN & JOHN T. SCOTT, MARKET STRUCTURE AND TECHNOLOGICAL CHANGE (1987).

[85] *See* Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Innovation*, *in* ESSAYS IN THE THEORY OF RISK-BEARING 144 (3d ed. 1976). Monopoly may also discourage innovation because a monopolist's employees may resist innovations that would threaten the existing organizational structure.

reasons why monopoly instead may encourage innovation, such as greater access to low cost internal finance, greater ability to take advantage of scale economies in R&D, and greater ability to appropriate the full value of its new ideas.[86]

Empirical researchers have sought to determine which of these theories are in practice the more important.[87] But methodological problems make the empirical results difficult to interpret,[88] and recent articles appear to identify biases that led many earlier studies incorrectly appear to suggest that seller concentration typically promotes innovation.[89]

The sobering conclusion from both economic literatures—the analysis of the relative incentives of fringe and leading firms to innovate set forth above and the complementary literature on the relationship between seller concentration and industry innovative effort—is that the primary determinants of innovation can readily vary from one industry to the

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[86] *See* JOSEPH SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 81–106 (1942); 1 MORTON I. KAMIEN, MARKET STRUCTURE AND INNOVATION REVISITED, JAPAN AND THE WORLD ECONOMY 331 (1989).

[87] *See generally* Cohen & Levin, *supra* note 67, at 1074–79; JOHN SCOTT, PURPOSIVE DIVERSIFICATION AND ECONOMIC PERFORMANCE 84–90 (1993); Baldwin & Scott, *supra* note 84, at 63–113.

[88] A typical study compares research and development intensity with seller concentration across a large number of industries. The many methodological problems raised by this approach include the following four. First, R&D intensity, an input into innovation, may not be a good proxy for innovation rates. Second, seller concentration (even in conjunction with some measure of entry barriers) may not be a good proxy for the extent of market power within an industry. Concentration does not necessarily beget market power, and concentration is typically measured for industry definitions at great variance from the conceptually appropriate markets. Third, the posited link between industry structure and innovation ignores the reverse possibility, that the extent of technological change affects the degree of concentration, and the possibility that both market structure and innovative activity derive from more basic sources. *Cf.* Joseph Stiglitz & Partha Dasgupta, *Industrial Structure and the Nature of Innovative Activity*, 90 ECON. J. 266, 267 (1980) (market concentration should not be treated as an exogenous determinant of innovative activity). Fourth, the results will be biased if cross-industry differences in the opportunity for innovation, or differences in the degree to which firms can appropriate the gains from innovation, are related to market structure.

[89] One recent study identifies a large "pro-Schumpeterian bias" in the prior literature resulting from the failure to control for the first and fourth problems indicated in the previous note. P.A. Geroski, *Innovation, Technological Opportunity, and Market Structure*, 42 OXFORD ECON. PAPERS 586 (1990). Other recent studies demonstrate that when variation in the degree of appropriability across industries is controlled for, the previously apparent relationship between innovation and product market concentration largely disappears. Richard C. Levin et al., *R&D Appropriability, Opportunity, and Market Structure: New Evidence on Some Schumpeterian Hypotheses*, 75 AM. ECON. REV. 20 (Papers and Proceedings, May 1985); *cf.* SCOTT, *supra* note 87, at 87 (the relationship between seller concentration and R&D intensity also disappears once company and industry specific effects—which potentially reflect appropriability conditions—are controlled for); *but cf.* Zvi Griliches, *Comments on Levin, Klevorick, Nelson & Winter*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 824 (questioning the strength of the appropriability measure also used by Levin et al., *supra.*).

next.[90] Accordingly, any effort to understand the influence of changes in market structure on innovation—the problem confronting antitrust enforcers and courts—should pay attention to the specific factors affecting firm R&D investments in individual industries through a case-by-case analysis.

[90] Similarly, empirical economists have learned the critical role of industry-specific factors in identifying the exercise of market power. *See* Timothy Bresnahan, *Empirical Studies of Industries with Market Power*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1011–57 (Richard Schmalensee & Robert D. Willig eds., 1989).